The Nature of Experience

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Abstract

In many environments, exogenous ('natural') and strategic uncertainty jointly determine outcomes for individuals and an increasing number of economic experiments attempt to study human behavior in such settings. We design a choice environment that allows to study how individuals change their actions in repeat play depending on whether natural or strategic factors uniquely caused an adverse outcome. As expected, we find no statistically significant evidence that the experience of a zero-payout events affects whether subjects change their choice between rounds. However, there is significant evidence for a 'human factor': Despite statistical equivalence, subjects are significantly more likely to change their choice after experiencing adverse outcomes caused by strategic uncertainty, but not after experiencing the same outcome caused by natural uncertainty.

Keywords: Uncertainty; Behavioural experiment; Learning; Stochastic damages

1 Introduction

Risk is an important feature in many situations in which an ecological system is exploited by a group of economic agents. There are at least two potential sources of risk present in such situations. One is natural: Ecological systems are subject to stochastic fluctuations that can lead to adverse economic outcomes for humans reliant on these systems. The other is social: Within the group of agents, agents may deviate for strategic reasons from the behavior expected by others and thereby adversely affect the economic outcomes of other in the group. In such settings, economic agents face strategic risk. And in many exploited ecological systems, both natural and strategic risks are simultaneously present: Fishermen, for example, are reliant on target populations that exhibit strong natural fluctuations due to variations in nutrient supply or climatic factors. At the same time, they are exposed to the harvesting decisions of other fishermen that affect the likelihood of fishing success. Both risk sources lead to a deleterious outcome for the fisherman, either individually and jointly.

Over the last decades, an experimental literature has started to investigate under controlled conditions whether and how the presence and scale of natural risk, i.e. the exogenous stochasticity in a setting, affects the degree of cooperation, i.e. the presence and scale of strategic risk, in social dilemmas. For example, (Dickinson, 1998) compares public good games with a certain public good provision and those with a probabilistic provision and finds that cooperation is lower when public goods are uncertain. Keser and Montmarquette (2008) introduce the possibility of reducing the riskiness of public goods provision through contributions, comparing risky and ambiguous decision environments and also find a negative relationship between initial riskiness or ambiguity and contributions. Lohse et al. (2012) consider a richer decision environment in which subjects can choose between contributing towards reduction of loss probability and toward reduction of loss size. Köke et al. (2015) report on an experiment with the same two options and study in greater detail than earlier contributions the specific behavioral adaptation in subjects after experiencing adverse events caused by a stochastic environment. They find evidence for reinforcement learning: Adverse events shift defecting players towards cooperation, and the absence of losses leaves existing cooperation intact. Ghidoni et al. (2017) study a setting with additional complications such as delayed and stochastic damages in order to capture more features of the climate change context that inspires their paper. They find little impact of stochasticity and delay on the extent of cooperation.

Going against the trend of ever richer decision environments, the present paper revisits an important feature of the dual presence of natural and strategic uncertainty in common pool resource problems that jointly determine outcomes for individuals and groups of resource users. Previous experiments provide indicative, but not unequivocal evidence that subjects change their behavior in response to an adverse event. However, previous designs cannot inform us about whether behavioral responses are different depending on the source of the adverse event. Are adverse events caused by natural fluctuations more important drivers of behavioral change than adverse events caused by strategic decisions of others – or perhaps less important? The answer to this question has substantive implications both for our interpretation of the existing experimental evidence as well as for policies.

For the existing evidence, it means that source attribution is a mediating factor in behavioral responses. Our interpretation of the evidence needs to take into account what subjects believed was the cause of the adverse event. The same history of losses can lead to very different cooperation outcomes depending on the relative (perceived) roles of natural and strategic risk. For policies directed at the cooperative management of common-pool resources, it means that policies targeting natural and strategic risks generate different group benefits. This differential needs to be taken into account, alongside costs, when policy-makers decide which source of risk to target for policy action.

The main challenge for identifying whether behavioral responses to natural and strategic risks are essentially different or essentially the same lies in the design of an experimental

setting in which both risks differ in little more than the source. Our design answers to this challenge by setting up a choice environment in which individuals can change their actions in repeat play and vary whether natural or strategic factors uniquely or jointly caused an adverse outcome.

A key feature is that the environment is parametrized to render natural and strategic uncertainty statistically and strategically equivalent. Also, it is designed to rule out gains from learning. The equivalence in all these dimensions is accomplished through the adoption of the Chicken Game form, a paradigm that captures many salient features of common-pool resources in the most parsimonious way. In our design, the two-person Chicken Game is modified slightly by the addition of an urn that mimics natural risks and has the same probabilistic and material features as the strategic risk resulting from the co-player in the Chicken Game: The likelihood and consequences of encountering a co-player that behaves non-cooperatively are the same as drawing an unfavorable outcome ("red ball") from the urn. There is a random rematching of co-players between the two rounds, thus maintaining statistical equivalence between the rounds despite the experiences after round 1. To ensure that a sufficient number of subjects are exposed to both potential sources of risk irrespective of their own strategic preferences, we include a treatment with a pre-assigned first-round action alongside a conventional treatment in which subjects can choose their action in both rounds. We also elicit instinctive beliefs among players about the concrete realizations of natural and strategic risk after every round, thus obtaining a measure not just of the experience of adverse events, but also the strength of the experience relative to the instinctive expectations.

We administer our design to 1982 participants through an online platform (Amazon Mechanical Turk). As expected, we find no statistically significant evidence that subjects change their choice between rounds. However, there is significant evidence for a "human factor" when the sources are taken into account: Despite statistical equivalence, subjects are significantly more likely to change their choice after experiencing adverse outcomes caused by strategic uncertainty, but not after experiencing the same outcome caused by natural uncertainty. Our results help interpret experimental evidence in this emerging research area with implications for common pool resource experiments, public good games, and others.

2 Experimental design

The experiment is designed to cleanly disentangle strategic uncertainty from natural uncertainty.[1] We match participants with a co-player to play a game of chicken (normal-form matrix is shown in Figure 1). The eventual payoff of the players depends on their play in the game and on the draw of a lottery. That is, when a "red ball" is drawn in the lottery, or when both players choose "action B" in the chicken game, they receive a payoff of zero. When a participant chooses "action A" in the chicken game, and a "green ball" is drawn in the lottery, she receives a payoff of x and when a participant chooses "action B" in the chicken game, while her co-player chooses "A", and a "green ball" is drawn in the lottery, she receives a payoff of $x + y$.

		Player 2	
		A	B
Player 1	A	x , x	x , $x + y$
	B	$x + y$, x	0 , 0

Figure 1: Normal form of the chicken game

We play two rounds of this game and randomly rematch players (perfect stranger matching). After the first round, full information about the outcome of the lottery and the choice of the matched co-player is provided. Participants receiving a payoff of zero will therefore know exactly whether their payoff can be attributed to the unfortunate realization of the natural uncertainty, or the strategic uncertainty, or both. In round two, participants are tasked to again choose between A and B.[2]

Because natural and strategic uncertainty are independent, there are eight different histories in the first round of the experiment that we present in Table 1. We introduce the following notation: The choice of player i in round t is denoted by $C_{i,t} = \{\text{A}; \text{B}\}$ (parallel for player j). The realization of the lottery is denoted by $L_t = \{\text{red}; \text{green}\}$. The payoff of player i for round t is denoted by $\pi_{i,t}$. For easier reference, we number the eight different histories in the first round H=h1,...,h8. The last column of Table 1 gives the probability that a given history occurs, where we denote the probability that a red ball is drawn in the lottery by p (that is, $p = \Pr(L = \text{red})$) and the probability that participant chooses "action B" by q. This means, for example, that the history h1, according to which a green ball is drawn from the urn and both players choose "A", occurs with probability $(1 - p)(1 - q)^2$.

[1] In economics, the terms "risk" and "uncertainty" are often used to mean two different situations. Risk then refers to a situation where the probability with which an event out of a set of potential outcomes occurs is known, and (Knightian) uncertainty refers to a situation where the probabilities with which an event out of a set of potential outcomes occurs is not known. Here, we do not attempt to strictly differentiate between these two terms. We use the broader and more common term of uncertainty, also to acknowledge that participants may be perceive the situation as uncertain, even though we explicitly tell the participants the probabilities with which the events are to occur.

[2] Only one of the two rounds will be randomly selected for payout so that there are no income effects

Table 1: The eight different histories of the first round

H	$C_{i,1}$	$C_{j,1}$	L	$\pi_{i,1}$	$\Pr(H{=}\mathrm{h}n)$
AAg	A	A	green	x	$(1-p)(1-q)^2$
AAr	A	A	red	0	$p(1-q)^2$
ABg	A	B	green	x	$(1-p)(1-q)q$
ABr	A	B	red	0	$p(1-q)q$
BAg	B	A	green	$x+y$	$(1-p)q(1-q)$
BAr	B	A	red	0	$pq(1-q)$
BBg	B	B	green	0	$(1-p)q^2$
BBr	B	B	red	0	pq^2

Observing the behavior of experimental subjects in both rounds allows us to investigate whether the experience of a zero-payoff outcome in the first choice situation affects participant's behavior in a second choice situation. Furthermore, comparing the behavior in the second choice situation after a zero-payoff event has been uniquely caused by the actions in the chicken game (strategic uncertainty) or by the lottery draw (natural uncertainty) allows us to determine whether the source of the zero-payoff matters.

The fundamental challenge to identify whether the reason for the zero-payoff event matters for changing the choice in the second situation is that only those participants that choose "action B" in the first round are in a position to experience both natural or strategic uncertainty. For those participants that choose "action A" in the first situation, only natural uncertainty can be the cause of the zero payoff event. Obviously, this could lead to a significant selection bias.

To overcome this, we conduct two treatments. First, the "real action" treatment (**RA**), where participants take a real choice in both rounds, and second, the "assigned action" treatment (**AA**), where we assign the first round choice B to the participants. The participants' payoff in the first round of the "assigned action" treatment is determined by matching their action with a first round choice from the "real action" treatment. In the second round, participants in the AA-treatment take a real choice as well. Before presenting the first round to these participants, we elicit their preferred action (this is not done in the RA-treatment, obviously). We can test whether the first round in the AA-treatment was indeed successful in inducing "experience" in spite of the external assignment of action by comparing the second round behavior between the treatments conditional on the expressed preference for the first round action.

Another concern for identification could be that players may react to differences in the perceived likelihood of a zero-payoff event stemming from the two sources of uncertainty. As can be seen from Table 1, for a given q, we can calibrate p to obtain different distributions of our sample over histories (at least in terms of ex-ante likelihood). We aim

that carry over from the first to the second round of the game.

for a distribution where it is equally likely that the zero payoff event is uniquely caused by both player's choosing "B" or by the ball being "red", which requires[3] $p = q^2$.

Of course, q is unknown as it depends on the behavior of the participants (this may, in fact, depend on p, even though the two probabilities are independent). To this end, we have conducted three pilots with different values of p and observed the resulting q in the first decision that participants took. Specifically, we observed a value of q=0.36 in the pilot with p=0.4 (N=81), a value of q=0.38 in the pilot with p=0.2 (N=107), and a value of q=0.47 in the pilot with p=0.1 (N=92). Although we do see that the point estimate of q decreases with p, these values are statistically indistinguishable. Given the data from the pilot, we set p=0.2.

To provide sufficient incentives, we set the payoffs to x=1 USD and y=2 USD, which is comparatively high for short surveys that are offered in online labor markets.

2.1 Implementation

The experiment is conducted online with participants being recruited from the Amazon Mechanical Turk platform. We use o-Tree (Chen et al., 2016) to program the experiment. The full instructions are provided in the Appendix. Figure 2 illustrates the flow of the experiment.

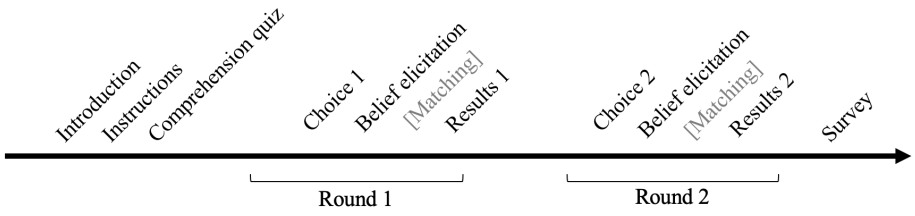

Figure 2: Stages of the experiment

After the introduction where participants give consent to participate, we present the rules of the game. We also announce, based on past experience with the pilots, the likelihood of the co-player playing A or B. The participants then have to complete seven comprehension questions. In the "assigned action" treatment, we ask participants for their preferred choice of action, followed by a screen that announces their assigned action (B in all cases). In the "real action" treatment, participants are simply asked for their real choice. After the choice, participants are asked about their belief about the probability that the ball drawn was red or that their co-player chose action B. Finally, we match participants with co-players' choices and calculate the resulting earnings. In the AA treatment, the respective co-player's choice is a random draw (with replacement) from the observed first-round choices from the first session of the RA treatment (N=300).

[3] $\Pr(H = \text{BBg}) = \Pr(H \in \{\text{AAr,ABr,BAr}\}) \Rightarrow (1-p)q^2 = p(1-q)^2 + 2pq(1-q) \Leftrightarrow p = q^2$.

The second round in the RA treatment is identical to the first round. In the AA treatment, participants now have real choice, so that the second round in the AA treatment is identical to the second round of the RA treatment. After making a choice in round 2, we ask participants about the reason why they have (or have not) changed their choice between round 1 and round 2. After seeing the results from the second game, participants take a short survey, completing the experiment. In the survey, we ask about age, gender, educational level, and a generic assessment about their willingness to take risks.

3 Hypotheses and testing

In this section, we describe our specific hypotheses and how we aim to test them. We have three overarching research questions: First, does the experience of a zero payoff outcome in the first round affect choice in the second round? Second, does it make a difference whether the zero payoff outcome was attributable to strategic or natural uncertainty, that is, does the nature of experience matter? Third, which participant characteristics can explain their choice and the potential reaction to a zero payoff outcome?

Before we turn to how we operationalize these three questions and test the corresponding hypotheses, it us useful to define an indicator of change in choice in the following way: Let Y_i=0 if $C_{i,1}$=$C_{i,2}$ and Y_i=1 if the action chosen in the second round is the opposite of the action implemented in the first round ($C_{i,1}\neq C_{i,2}$).

In addition, we recall the variable definitions used in Table 1: The set of histories "AAg" to "BBr" is denoted by H and the outcome of the lottery is denoted by L_t. The treatment condition T is either RA for "real action" or AA for "assigned action".

3.1 The effect of experience

Provided that all participants are fully rational players and believe that all other participants are also fully rational, standard game theory gives a clear prediction about the outcome of the experiment. The strategic choice situation of the participants has the form of a chicken game. The chicken game has a Nash equilibrium in mixed strategies ($q^* = \frac{2}{3}$). Subjects are informed about previous average play in this game form and given the same parametrization. Subjects are also informed about the probability of a bad draw in the lottery. Moreover, the probability is independent of the strategic choice and partner reassignment between rounds is randomized. Both the information about average play and about the lottery remain the same in the first and the second round. In such a setting, standard game theory predicts that no change in **average** behavior should be observed.

If deviations from fully rational play or from the belief in other players' fully rational play are taken into account, then alternative predictions about average behavior arise. Deviations from fully rational play could come from any one of several different behavioral effects:.

- *Regret* Participants that have experienced a zero-payoff event may want to minimize the chance of experiencing it again and chose action A in the second round, in particular those that have caused the event to occur by choosing B in the first round.
- *Recency effect* Participants could update their beliefs about the lottery or about the co-player's action in the direction of the most recent observation, even though the probabilities have not changed statistically.
- *Variety effect* Participants could value variety of choice for its own sake.
- *Experimentation effect* Participants could believe that they learn something about the game by changing play.

This characterization of alternative behaviors is neither exhaustive nor complete. Likewise, the beliefs in the population about the presence of rational or alternative behavioral types are unknown. The agnostic prediction is therefore captured in hypothesis 1.

Hypothesis 1 *Experience does not affect behavior.*

Because the probability to experience the zero-payoff event is strictly decreasing in the probability to choose action A, a direct but naïve way of testing hypothesis 1 would be to compare the propensity to choose action A in the second round between those participants that have experienced a zero-payoff event in the first round and those that have not. Such a test could lead to a false positive, however. For example, the average proportion of participants that choose $C_{i,1}{=}A$ conditional on not observing a zero-payoff outcome is higher than the average proportion of participants that choose $C_{i,1}{=}A$ conditional on observing a zero-payoff outcome, even if no participant reacts to the experience of the zero-payoff event. Rather, one must investigate the change in choice to test whether experience affects behavior. In other words, we test hypothesis 1 using a binomial test, where we expect:

$$\mathrm{E}[Y|H{=}\mathrm{BAg} \wedge T{=}RA] \;=\; \mathrm{E}[Y|H{\in}\{\mathrm{BAr},\mathrm{BBg},\mathrm{BBr}\} \wedge T{=}RA] \tag{1}$$

$$\mathrm{E}[Y|H{=}\mathrm{BAg} \wedge T{=}AA] \;=\; \mathrm{E}[Y|H{\in}\{\mathrm{BAr},\mathrm{BBg},\mathrm{BBr}\} \wedge T{=}AA] \tag{2}$$

Note that by conditioning on history h3, h4, h7, or h8, we consider only those participants with action B in the first round (see Table 1). As a consequence, a value of $Y_i{=}1$ uniquely means $C_{i,2}{=}A$.

As indicated above, we conduct this test for each treatment separately. The prime group of interest are those participants that were all assigned action B in the first round (AA treatment). For the RA treatment, only those participants that preferred action B were in a position to experience a zero-payoff event due to both strategic or natural uncertainty. As participants that choose $C_{i,1}{=}B$ may differ, also along unobservable

dimensions, from participants that choose $C_{i,1}$=A, there may be a selection effect in in the RA treatment. An indication for such a selection effect could be a difference in the *relative* propensity to change choices in the different treatments.

3.2 The nature of experience

Turning to the question whether it makes a difference if the zero payoff outcome is attributable to strategic or natural uncertainty, we simply compare the average change in choice after experiencing history h4, according to which the strategic situation uniquely caused the zero-payoff event, with the average change in choice after experiencing history h7, according to which the draw from the urn uniquely caused the zero-payoff event. Again, we formulate an agnostic hypothesis that we test for each treatment separately.

Hypothesis 2 *The differential nature of experience does not affect behavior.*

$$\mathrm{E}[Y|H{=}\mathrm{BBg} \wedge T{=}RA] \;=\; \mathrm{E}[Y|H{=}\mathrm{BAr} \wedge T{=}RA] \tag{3}$$

$$\mathrm{E}[Y|H{=}\mathrm{BBg} \wedge T{=}AA] \;=\; \mathrm{E}[Y|H{=}\mathrm{BAr} \wedge T{=}AA] \tag{4}$$

3.3 Participants' characteristics

Individual characteristics may play an important role. We will control for participants' characteristics such as age, gender, level of education, as well as their beliefs about the co-player's action and their general propensity to take risks in a multivariate analysis.

We explore these effects by regressing the first period choice (C_1; the chosen action in the RA treatment and the preferred action in the AA treatment) and the indicator of a change in choice (Y) on the explanatory variables. As the dependent variables are binary, logit regression models are suitable.

There is ample of evidence for women being more risk averse than men (Eckel and Grossman, 2008; Croson and Gneezy, 2009). Similarly, age has been found to affect behavior in these types of games, yet in a weaker fashion (Harbaugh et al., 2002). The educational level in turn is unlikely to have strong behavioral effects, but it may explain why participants do not switch actions, as more educated participants (and in particular those with a degree in math and sciences) are more likely to understand the independent nature of the two types of uncertainty.

With respect to the self-reported level of risk aversion, the clear hypothesis is that the higher the risk aversion, the more likely it is that a participants prefers action A. Similarly, we expect that the stronger the belief that the other player chose action B, the more likely it is that a participants prefers action A.

Finally, we explore whether the reasons that participants give at the survey to justify the choice they have made in the second period can shed a light on the mechanisms that may be at play for explaining the observed outcomes.

4 Results

The Experiment was conducted via amazon m-turk and took place on March 11-13, 2019. There are in total 1982 participants in our sample. The mean age in our sample is 36.9 years and 48% of the participants are female. We have 986 participants in the "real action" (RA) treatment and 996 participants in the "assigned action" (AA) treatment. There are no differences in age or gender composition between the treatments.

In the RA treatment, 41.5% choose action B (in the first round) and in the AA treatment 37.9% prefer action B. Neither choice proportion in the RA or the AA treatment is different from the announced 40% at the 5% level (p-value =0.346 and 0.174, exact binomial test), and the two proportions also do not differ at the 5% level from each other (p=0.108, two-sided test of proportion).

Before we move on to describe which histories participants experience before making their second round choice, we note that it is astonishing how closely the experimentally assigned probabilities and actual choices match accross the different treatments.

Table 2 shows the distribution of our sample over the different possible histories. A history is the combinattion of the person's own choice $C_{i,1}$, the co-player's choice $C_{j,1}$, and the outcome of the lottery L. Column two shows the number of participants that experienced a respective history in the AA treatment (where all participants were assigned the choice "B" in the first round). Coiumn three shows the respective probabibilty to switch to a different action in round 2. Column six and seven on the right show the corresponding sample size and switch prbability for the RA-treatment. Here, participants had a real choice and we see about 60% of the participants indeed chose action A in the first round. Column four and five then show the distribution of the sample in the AA treatment when we take their expreesseed preference, and not their assigned action, as basis.

Table 2: Sample size and switching probability given the different histories.

H	AA: N	AA: Y=1	AAp: N	AAp: Y=1	RA: N	RA: Y=1
AAg			293	0.73	240	0.30
AAr			66	0.77	107	0.31
ABg			218	0.78	163	0.26
ABr			58	0.84	67	0.42
BAg	469	0.57	186	0.24	165	0.23
BAr	105	0.52	41	0.07	67	0.19
BBg	347	0.62	132	0.33	123	0.37
BBr	91	0.65	34	0.26	54	0.31

4.1 Does experience affect second-round choices?

The first question we raised in the pre-plan was whether participants respond to an adverse outcome by changing their choice between the first and the second period. Specifically, we have E[$Y|H$=BAg $\wedge$ T=RA]=0.23 and E[$Y|H$=BAr,BBg,BBr $\wedge$ T=RA]=0.31 with no significant difference between the two (p=0.11, two-sided test of proportions). For the AA treatment, we have E[$Y|H$=BAg $\wedge$ T=AA]=0.57 and E[$Y|H$=BAr,BBg,BBr $\wedge$ T=AA]=0.61 with again no significant difference between the two (p=0.22, two-sided test of proportions). This gives our first result:

Result 1 *Experience does not affect behavior.*

Thus, we confirm that, on average, experiencing a zero payout event does not lead to a different probability in changing the choice between rounds. In the right part of Figure 3 we present the transition matrix for the RA treatment and in the left part we present the transition matrix for the AA treatment (using the expressed preferences). We see that by and large about 30% of the participants choose a different action in round 2 than their action/preference in round 1, with the exception of those that were assigned action B but preferred action A, where only about 20% switched.

Choice 1 \ *Choice 2*	A	B
A	0.69	0.31
B	0.28	0.72

(a) RA treatment

Preference 1 \ *Choice 2*	A	B
A	0.79	0.21
B	0.27	0.73

(b) AA treatment

Figure 3: Transition matrices

Our second hypothesis was then concerned with the specific history that participants expereienced. In particular, we are interested in knowing whether participants that experienced a zero payoff event that was uniquely caused by strategic uncertainty (the co-player choosing action B while the ball was green, h4) behave differently from those where the event was uniquely caused by natural uncertainty (the co-player choosing action A while the ball was red, h7).

Figure 4 illustrates the share of participants that switch from action B to action A in the RA treatment and in the AA treatment, respectively. We see that in both treatments, more people switch after experiencing a zero payoff event that was uniquely caused by strategic uncertainity rather than natural uncertainty. Formal statistical tests reveal that this difference is significant for the RA treatment (p=0.022, two-sided test of proportion), but not for the AA treatment (p=0.096, two-sided test of proportion).

Recall that in the AA treatment, all participants were assigned action B in the first round, regardless of their preference. Thus we would expect a much higher fraction of

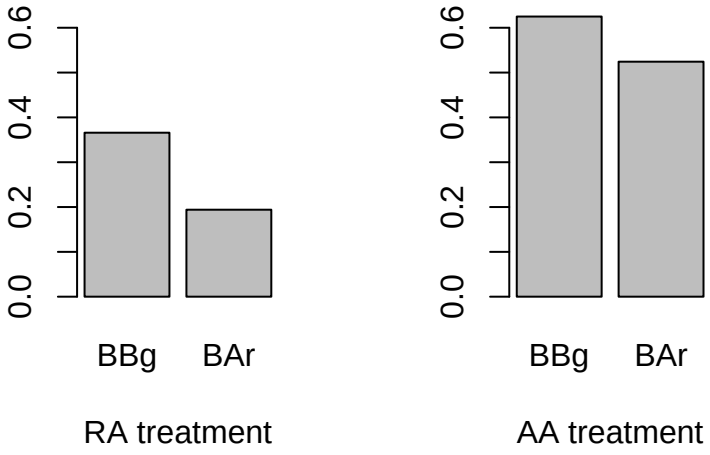

Figure 4: Share of participants changing their choice after different histories

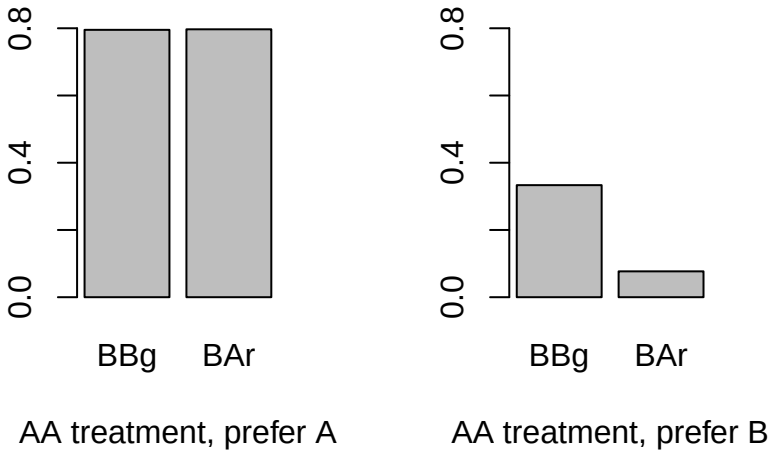

Figure 5: Share of participants changing their choice after different histories

participants to switch, simply because they were assigned an action that they did not prefer. In Figure 5 we thus show the share of switchers in the AA treatment depending on whether they actually preferred action A (left panel) or action B (right panel).

First, we note that about 80% of the participant switched from B to A if they indeed preferred A, regardless of whether the zero payoff event was caused by strategic or natural uncertainty. In contrast, only few of those that preferred B and were assigned B switched to A in the second round. Here we see a clear difference between those that experienced the zero payoff event because of strategic or natural uncertainty (33% versus 8%). This difference is strongly significant (p=0.003, two-sided test of proportion).

All in all, wee thus reject our second hypothesis and state the following result:

Result 2 *The differential nature of experience affects behavior.*

4.2 Why does the nature of experience affect second-round choices?

To sum up, a key feature of our experiment is that it renders natural and strategic uncertainty statistically and strategically equivalent. Also, it is designed to rule out gains from learning. And indeed, it turns out that the overall share of participants choosing action B matches the information in the instructions and the expectations of the participants almost up to the decimal point. As expected, we find no statistically significant evidence that the experience of a zero-payout events affects whether subjects change their choice between rounds. However, there is significant evidence for a 'human factor': Despite statistical equivalence, subjects are significantly more likely to change their choice after experiencing adverse outcomes caused by strategic uncertainty, but not after experiencing the same outcome caused by natural uncertainty. This begs the question why the nature of experience affects second-round choices.

In Table 3, we present the results of a logit regresson, explaining whether a participant has changed her choice. The first column shows the results for the AA-treatment and the second column shows the result from the participants in the AA treatment when we take their stated preference, rather than their assigned action as basis. The sample in the third column are the participants that chose action B in the first round.

The regression results confirm the evidence from the non-parametric tests. Interestingly, the difference between those that switch from (prefering or choosing) B to A is driven by different factors in the RA and the AA treatment. In gthe RA treatment, those that see their co-playere choosing B are more likely to switch B, and in the AA treatment, those that see a red ball are less likely to switch.

We further note that the co-variates age, gender, and eductaion have explanatory power. Risk aversion explains switching to A in the overeall AA sample (first columnb), but not for those that preferred or chose action A (second and third column). This is not surprising.

Finally, we construct a variable "surprise" that takes a value of 0 when the observed outcome of the ball, or the co-player's action, conforms perfectly with the stated gut-feeling and a value of 100 if the observed outcome diverges maximally from the gut feeling. Here, we see that obsereving a different outcome of the urn draw is important for explaining switching in the AA treatment, but not in the RA treatment. In the latter, we see that it is particularly those that are surprised by the co-player's action that switch to choosing B.

Table 3: Switching from B to A (logit regression)

	Switch B to A		
	AA	AAp	RA
Red ball	-0.543**	-1.512**	-0.121
	(0.249)	(0.630)	(0.374)
Other B	0.279*	0.365	0.480**
	(0.155)	(0.234)	(0.242)
Red Ball x Other B	0.156	1.079	0.129
	(0.337)	(0.723)	(0.458)
Ball surprise	0.009***	0.005	-0.003
	(0.002)	(0.004)	(0.004)
Action surprise	-0.002	-0.006*	0.006**
	(0.002)	(0.003)	(0.003)
Risk aversion	0.147***	-0.015	-0.026
	(0.027)	(0.042)	(0.039)
Age	-0.002	-0.000	0.007
	(0.006)	(0.010)	(0.009)
Female	-0.117	0.193	0.158
	(0.135)	(0.218)	(0.208)
Education	0.092*	0.159*	-0.044
	(0.053)	(0.091)	(0.077)
Constant	0.703**	-2.845***	-2.784***
	(0.342)	(0.580)	(0.532)
Observations	996	996	986
Log Likelihood	-649.526	-314.876	-342.752

Standard errors in parentheses.

Column AAp is based on stated preference, rather than actual choice.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Appendix – Instructions

Instructions

Legend: [page references], [treatment differences], [user interface elements], [check elements]

[mTurk title]
Research in Decision Making

[mTurk description]
Participate in a game and a short survey. Please note that the task is to be completed within 10-15 minutes as you are matched with a co-player.

[mTurk preview, on separate screen]

Please read this carefully before clicking 'accept'.
This HIT is an academic research study on decision making.

Research goal:
In this study, we are interested in decision making under uncertainty. You will be matched with co-players and you will be asked to take a decision.

Duration and reward:
The entire study will take about 10 minutes. Your payment consists of a fixed reward of $0.50 via Amazon Mechanical Turk for successful completion and a bonus that depends on your and the co-players' decisions as well as on chance. You are also asked to complete a short and anonymous survey.

Please note that the task should be completed without delay.

Confidentiality:
All data we collect is treated confidentially and will only be used for our research purpose. Your name will not be linked to the results in any way.

Requirements:
To participate, you need to be located in the United States of America. You may not have participated in this study before. There are no other formal requirements for participation.

Voluntary participation:
Participation in this study is voluntary. If you do not want to take part in the study, please do not accept the HIT. If you want to participate, please be sure you can commit to completing the HIT before accepting it - if you discontinue participation, you will not receive any bonus.

Contact:
If you have any questions regarding this study, please contact Florian Diekert natcoop@awi.uni-heidelberg.de.

[accept HIT]

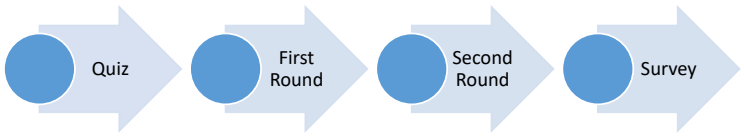
[Introduction]

Introduction
Thank you for participating.

If you read these rules carefully and choose wisely, you can earn up to US$ 3.50 by participating in a game that involves other participants.

Completing this task will take about 7 minutes and it is important that you pay close attention during this time so that you do not spoil the task for you and the other participants.

After we have explained the game, there comes the task. The task has four stages.



First, you take a small **quiz** about the game.

Then you are matched with another participant and the **first round** of the game is played.

Thereafter, you are matched with a different participant and the **second round** of the game is played.

Finally, you are asked to fill out a short **survey**.

Note that only one of the two rounds will be selected for payment at random. As it is unknown which of the two rounds counts, it is important to pay equally close attention to both.

[next]

[Instructions 1]

Rules

You will be a player in a game. Here are the rules.

There is the player, a co-player, and a virtual urn that contains 100 balls, some red, some green.

For each player, three factors together determine the payoff:
(1) The draw of a ball from the urn,
(2) The player's own action, and
(3) their co-player's action.

The player and the co-player take one of two actions, either **A** or **B**. The urn from which the ball is drawn contains 20 **red** balls and 80 **green** balls. Both player and co-player learn the color of the draw and the other player's action at the end of the round.

If a **red** ball is drawn, the actions of the player and the co-player do not matter for the outcome. The player receives nothing (US$ 0). So does the co-player (US$ 0).

If a **green** ball is drawn, then the actions of the player and the co-player matter for the outcome. There are four possibilities:

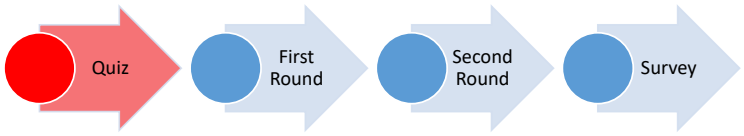
- A **green** ball is drawn and the player's **action is A** and the **co-player's action is A**: The player receives US$ 1. So does the co-player (US$ 1).
- A **green** ball is drawn and the player's **action is A** and the **co-player's action is B**: The player receives US$ 1. The co-player receives US$ 3.
- A **green** ball is drawn and the player's **action is B** and the **co-player's action is A**: The player receives US$ 3. The co-player receives US$ 1.
- A **green** ball is drawn and the player's **action is B** and the **co-player's action is B**: The player receives nothing (US$ 0). So does the co-player (US$ 0).

In a previous experiment, the co-players' action was **A** in about 60 out of 100 cases and **B** in about 40 out of 100 cases.

[next]

[comprehension 1]

Quiz



Welcome to the quiz.

Here you have the chance to check whether you have properly understood the rules of the game. Please answer the following questions.

Question 1:
Which of the following is correct? In the first round and the second round, my co-player is
- the same participant in both rounds.
- a different participant in each round.

[Option 2 is correct]

Question 2:
Which of the following is correct? On average, co-players
- choose A more often than B.
- choose B more often than A.
- choose A and B equally often.

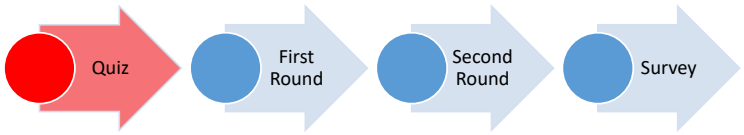
[Option 1 is correct]

Question 3:
Remember that only one of the two rounds counts for your payment, with equal chance. What does this mean?
- The outcome of round 1 is less important than the outcome of round 2.
- The outcomes of both rounds are equally important.
- The outcome of round 2 is less important than the outcome of round 1.

[option 2 is correct]

[comprehension 2]

Quiz



Question 4:
What is your payout if your action is A, your co-player's action is B, and the ball is red?
- US$ 0
- US$ 1
- US$ 3

[Option 1 is correct]

Question 5:
What is your payout if your action is A, your co-player's action is B, and the ball is green?
- US$ 0
- US$ 1
- US$ 3

[Option 2 is correct]

Question 6:
What is your payout if your action is B, your co-player's action is B, and the ball is green?
- US$ 0
- US$ 1
- US$ 3

[Option 1 is correct]

Question 7:
What is your payout if your action is B, your co-player's action is A, and the ball is green?
- US$ 0
- US$ 1
- US$ 3

[Option 3 is correct]

[check answers] [if correct / corrected: next]

Show payoff reminder

TREATMENT AA:
[elicitation; new screen; center vertically]

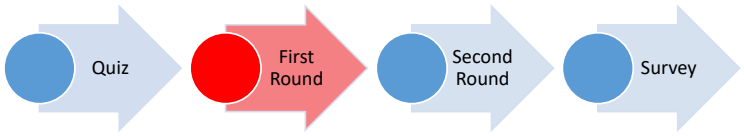
A final question, for which there is no right or wrong answer: Which action would you choose?

- Action A.
- Action B.

[force answer; then next.]

[decision 1]

First Round



Welcome to the first round of the game.

You are now a player in this game, where you can earn money if this round is selected for payout.

You are matched with another participant, your co-player for this round. Your co-player will choose an action, A or B, and a ball, red or green, will be drawn.

[TREATMENT AA]
In this round, your action, A or B, is **assigned** to you.

[TREATMENT RA]
Which action do you choose?
- A
- B

[instructions reminder box]
Remember: Your payoff is jointly determined by
- whether a red or a green ball is drawn from the urn, which contains 20 red and 80 green balls,
- whether your action is A or B, and
- whether your co-player's action is A or B.

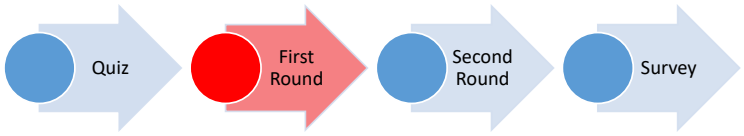
In a previous experiment, the co-player's action was A in about 60 out of 100 cases and B in about 40 out of 100 cases.

If a green ball is drawn, and
- your action is A, and your co-player chooses A: You receive US$ 1. Your co-player receives US$ 1.
- your action is A, and your co-player chooses B: You receive US$ 1. Your co-player receives US$ 3.
- your action is B, and your co-player chooses A: You receive US$ 3. Your co-player receives US$ 1.
- your action is B, and your co-player chooses B: You receive nothing (US$ 0). Your co-player receives nothing (US$ 0).

If a red ball is drawn, you and your co-player both receive nothing (US$ 0).

Please click ‘next’ to continue.
[next]

[TREATMENT AA: revelation, round 1 choice, new screen, center vertically]

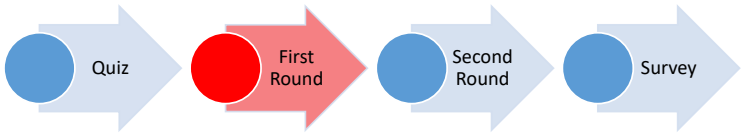


By assignment, your action in round 1 is:

{A/B}

[next]

[belief ball color 1, on separate screen]
First round: Questions

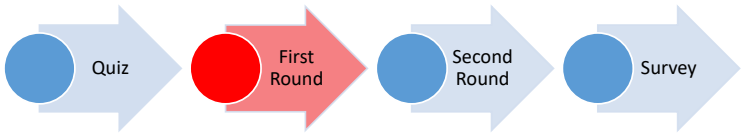


What is your gut feeling - is the color of the ball that was just drawn:

green or **red**?

[slider, 0-100]
[next]

[belief other's decision 1, on separate screen]
First round: Questions



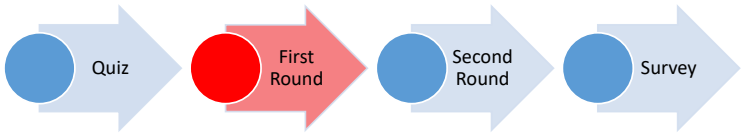
What is your gut feeling - did your co-player just choose:

A or **B**?

[slider, 0-100]
[next]

[Waiting room]

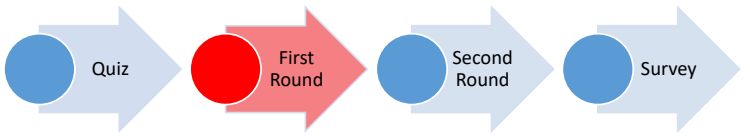
First round



Please wait while we match your action to your co-player's action.

[results 1]

First round: Results



Your action was **{A/B}**

Your co-player's action was **{A/B}**.

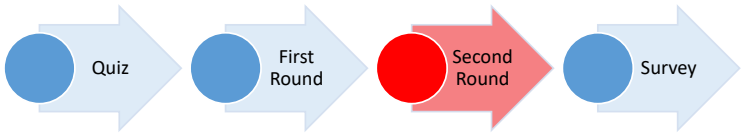
The ball drawn from the urn was **{green/red}**.

As a result, you earned **{payoff}** if this round is selected for payment.

Click on next to continue to the next round.

[next]

[decision 2; new screen]
Second Round



Welcome to the second round of the game, where you can earn money if this round is selected for payout.

You are matched with a different participant now, your co-player for this round. Your co-player will choose an action, A or B, and a ball, red or green, will be drawn.

TREATMENT AA: In this round, you choose your action, A or B.

Which action do you choose?
- A
- B

[instructions reminder box]
Remember: Your payoff is jointly determined by
- whether a red or a green ball is drawn from the urn, which contains 20 red and 80 green balls,
- whether your action is A or B, and
- whether your co-player's action is A or B.

In a previous experiment, the co-player's action was A in about 60 out of 100 cases and B in about 40 out of 100 cases.

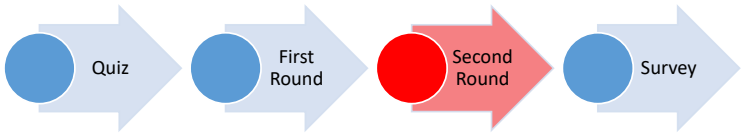
If a green ball is drawn, and
- your action is A, and your co-player chooses A: You receive US$ 1. Your co-player receives US$ 1.
- your action is A, and your co-player chooses B: You receive US$ 1. Your co-player receives US$ 3.
- your action is B, and your co-player chooses A: You receive US$ 3. Your co-player receives US$ 1.
- your action is B, and your co-player chooses B: You receive nothing (US$ 0). Your co-player receives nothing (US$ 0).

If a red ball is drawn, you and your co-player both receive nothing (US$ 0).

Please click 'next' to continue. [next]

[belief ball color 2, new screen]

Second round: Questions



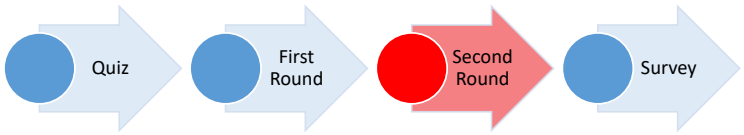
What is your gut feeling - is the color of that ball that was just drawn:

green or **red**?

[slider, 0-100]
[next]

[belief other's choice 2, on separate screen]

Second round: Questions



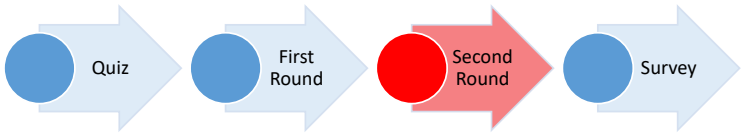
What is your gut feeling - did your co-player just choose:

A or **B**?

[slider, 0-100]
[next]

[elicitation of motivation]

Second round: Questions



CHANGERS
In round 2, why did you choose action 'x' and not action 'v' as in round 1?

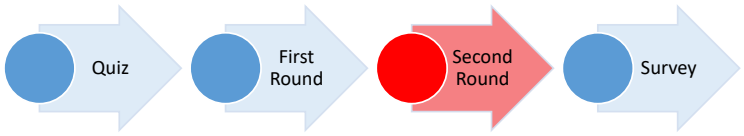
[1] Because I wish my action had been 'x' in round 1.
[2] Because my co-player played 'x' in round 1.
[3] Because I wanted to choose the opposite of my co-player's action in round 1.
[4] Because I wanted to learn something from trying the other action
[5] Because I have changed my opinion on what the best action is
[6] Other [please specify]: _____

NO-CHANGERS
In round 2, why did you choose action 'x' as you did in round 1?

[1] Because I am glad that my action was 'x' in round 1.
[2] Because my co-player played 'x' in round 1.
[3] Because I wanted to choose the opposite of my co-player's action in round 1.
[4] Because nothing has changed.
[5] Other [please specify]: _____

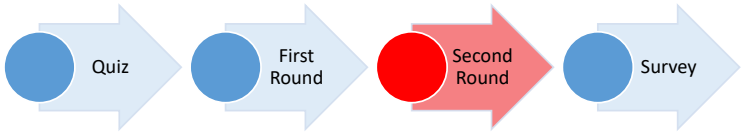
[Waiting room]

Second round



Please wait while we match your action to your co-player's action.

[results 2, on separate screen]



Results Round 2

Your action was **{A/B}**

Your co-player's action was **{A/B}**.

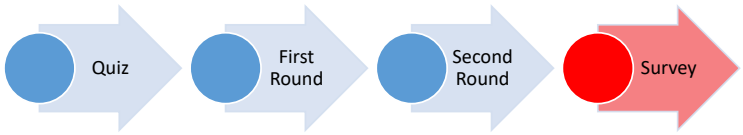
The ball drawn from the urn was **{green/red}**.

As a result, you earned **{payoff}** if this round is selected for payment.

[next]

[demographics]

Survey



Welcome to the survey. We ask you to answer a few questions before you complete the experiment.

What is your age?
[number input]

What is your gender?
- Male
- Female
- Other
- I prefer not to tell

What is the highest level of school you have completed or the highest degree you have received?
- Less than high school degree
- High School degree or equivalent (e.g. GED)
- some college, but no degree
- Associate degree
- Bachelor degree
- Graduate degree

If you had at least some college education, please tell us your major:
[free text input]

How do you see yourself: Are you in general a person who takes risk (10) or do you try to avoid risks (0)? Please self-grade your choice (0-10).
[slider, 0, 10]

[next]

[last page]

Completed

Thank you for your participation, your answers were transmitted.

Your payment consists of the fixed reward of US$ 0.50 and the payout from round 1 or round 2.

In your case, round **{1/2}** was randomly selected for payout, where you earned **{payoff}**. In total, you receive: **{payoff plus participation fee}**.

If you have any questions regarding this study, please write a mail to the study team natcoop@awi.uni-heidelberg.de.

[finish study]